

OpenXM/Risa/Asir-Contrib

OpenXM/Risa/Asir-Contrib User's Manual (English Edition)
Edition 1.3.2-3 for OpenXM/Asir2000
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by OpenXM Developing Team

1 Introduction

The computer algebra system `asir` can use servers, which support the `OpenXM` protocols (Open message eXchange for Mathematics, <http://www.openxm.org>), as components. The interface functions to call these servers are loaded by loading the file `OpenXM/rc/asirrc`. This file is automatically loaded in "Risa/Asir(OpenXM distribution)", which we call `OpenXM/Risa/Asir` in this document. This document explains these interface functions for `asir` and several mathematical and utility functions written in the user languages of Risa/Asir. These mathematical and utility functions are outcome of the Asir-contrib project.

The latest asir-contrib manual of the HEAD branch is at <http://www.math.kobe-u.ac.jp/OpenXM/Current/doc/index-doc.html>

As to technical details on the `OpenXM` protocols, see `openxm-en.tex` at `$(OpenXM_HOME)/doc/OpenXM-specs`.

Enjoy mathematics on your computer.

List of contributors:

- Maekawa, Masahide (Oct., 1999 – : CVS server)
- Noro, Masayuki (Jan., 1996 – : OpenXM Protocol OXRFC-100, asir2000)
- Ohara, Katsuyoshi (Jan., 1998 – : ox_math, oxc OXRFC-101)
- Takayama, Nobuki (Jan., 1996 – : OpenXM Protocol OXRFC-100, kan/sm1, asir-contrib)
- Tamura, Yasushi (Nov., 1998 – : OpenMath proxy, tfb)
- Fujimoto, Mitsushi (Windows)
- Iwane, Hidenao (Knapsack factorizer)
- Nakayama, Hiromasa (Gaussian elimination)
- Okutani, Yukio (Oct., 1999 – Feb., 2000 : matrix, diff, ...)
- Stillman, Mike (Macaulay 2 client and server)
- Tsai, Harrison (Macaulay 2 client and server)

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2 How to load Asir/Contrib

With loading `OpenXM/rc/asirrc`, we can use most functions in Asir/Contrib. The `OpenXM/Risa/Asir` reads this file, which is specified by the `ASIR_CONFIG` environmental variable, when it starts. The file `names.rr` is the top level file of the Asir/Contrib. Most other files are loaded from `names.rr`. Some packages are not loaded from `names.rr` and they must be loaded individually.

A sample of `asirrc` to use Asir/Contrib.

```
load("gr")$
load("primdec")$
load("katsura")$
load("bfct")$
load("names.rr")$
load("oxrfc103.rr")$
User_asirrc=which(getenv("HOME")+"/.asirrc")$
if (type(User_asirrc)!=0)
  if (!ctrl("quiet_mode")) print("Loading ~/.asirrc")$
  load(User_asirrc)$
else $
end$
```

3 Function Names in Asir Contrib

Not yet written.

Not yet written.

4 Asir-contrib for Windows

A part of Asir-contrib works on Windows. The following functions and components work on windows; the outer component sm1 and functions in asir-contrib which do not call outer components. In the cygwin environment, the outer components sm1, phc work. The other outer components do not work.

The following functions do not work on Windows. Some of them work in the cygwin environment of Windows.

- gnuplot.*
- om.*
- mathematica.*
- phc.*
- print_dvi_form
- print_gif_form
- print_open_math_xml_form
- print_png_form
- print_xdvi_form
- print_xv_form
- tigers_xv_form

5 Basic (Standard Functions)

5.0.1 base_cancel

`base_cancel(S)`

: It simplifies S by canceling the common factors of denominators and numerators.

Example:

```
base_cancel([(x-1)/(x^2-1), (x-1)/(x^3-1)]);
```

5.0.2 base_choose

`base_choose(L,M)`

: It returns the list of the order M subsets of L .

Example:

```
base_choose([1,2,3],2);
```

It outputs all the order 2 subsets of the set $\{1, 2, 3\}$

5.0.3 base_f_definedp

`base_f_definedp(Func)`

: returns 1 if the function $Func$ is defined.

5.0.4 base_flatten

`base_flatten(S)`

: It flattens a nested list S .

Example:

```
base_flatten([[1,2,3],4]);
```

5.0.5 base_intersection

`base_intersection(A,B)`

: It returns the intersection of A and B as a set.

Example:

```
base_intersection([1,2,3],[2,3,5,[6,5]]);
```

5.0.6 base_is_asir2018

`base_is_asir2018()`

: returns 1 if the system is asir2018.

5.0.7 base_is_equal

`base_is_equal(L1,L2)`

: returns 1 if the objects $L1$ and $L2$ are equal else return 0

5.0.8 base_makelist

`base_makelist(Obj,K,B,T)`
 : `base_makelist` generate a list from `Obj` where `K` runs in `[B,T]`. Options are `qt=1` (keep quote data), `step` (step size). When `B` is a list, `T` is ignored and `K` runs in `B`.

Example 0:

```
base_makelist(k^2,k,1,10);
```

Example 1:

```
map(print_input_form,base_makelist(quote(x^2),x,1,10 | qt=1, step=0.5))
```

Example 2:

```
base_makelist(quote("the "+k),k,["cat","dog"],0);
```

5.0.9 base_memberq

`base_memberq(A,S)`
 : It returns 1 if `A` is a member of the set `S` else returns 0.

Example:

```
base_memberq(2,[1,2,3]);
```

5.0.10 base_permutation

`base_permutation(L)`
 : It outputs all permutations of `L`. BUG; it uses a slow algorithm.

Example:

```
base_permutation([1,2,3,4]);
```

5.0.11 base_position

`base_position(A,S)`
 : It returns the position of `A` in `S`.

Example:

```
base_position("cat",["dog","cat","monkey"]);
```

5.0.12 base_preplace

`base_preplace(S,Rule)`
 : It rewrites `S` by using the rule `Rule`. `psubst` is used instead of `subst`. The replacement is not performed for function arguments.

Example:

```
base_preplace(exp(x)+x^2,[[x,a+1],[exp(x),b]]);
```

`x` is replaced by `a+1` and `exp(x)` is replaced by `b` in `exp(x)+x^2`.

5.0.13 base_product

`base_product(Obj, K, B, T)`

: `base_product` returns the product of `Obj` where `K` runs in `[B,T]`. Options are `qt=1` (keep quote data), `step` (step size). When `B` is a list, `K` runs in `B` and `T` is ignored.

Example 0:

```
base_product(k^2,k,1,10);
```

Example 1:

```
base_product(quote(x^2),x,1,10 | qt=1, step=0.5);
```

Example 2:

```
base_product(quote(x^2),x,[a,b,c],0 | qt=1);
```

5.0.14 base_prune

`base_prune(A,S)`

: It returns a list in which `A` is removed from `S`.

Example:

```
base_prune("cat",["dog","cat","monkey"]);
```

5.0.15 base_rebuild_opt

`base_rebuild_opt(Opt)`

: It rebuilt the option list `Opt`

Example:

```
base_rebuild_opt([[key1,1],[key2,3]] | remove_keys=["key2"]);
```

it returns `[[key1,1]]`

5.0.16 base_replace

`base_replace(S,Rule)`

: It rewrites `S` by using the rule `Rule`

Example:

```
base_replace(x^2+y^2,[[x,a+1],[y,b]]);
```

`x` is replaced by `a+1` and `y` is replaced by `b` in `x^2+y^2`.

5.0.17 base_replace_n

`base_replace_n(S,Rule)`

: It rewrites `S` by using the rule `Rule`. It is used only for specializing variables to numbers and faster than `base_replace`.

Example:

```
base_replace_n(x^2+y^2,[[x,1/2],[y,2.0+3*@i]]);
```

`x` is replaced by `1/2` and `y` is replaced by `2.0+3*in` in `x^2+y^2`.

5.0.18 base_set_minus

`base_set_minus(A,B)`
 : $A \setminus B$

Example:

```
base_set_minus([1,2,3],[3,4,5]);
```

5.0.19 base_set_union

`base_set_union(A,B)`
 : $A \cup B$

Example:

```
base_set_union([1,2,3],[3,4,5]);
```

5.0.20 base_subsequenceq

`base_subsequenceq(A,B)`
 : if A is a subsequence B, then it returns 1 else 0.

Example:

```
base_subsequence([3,2,5],[1,2,3,4,5]);
```

5.0.21 base_subsetq

`base_subsetq(A,B)`
 : if $A \subseteq B$, then it returns 1 else 0.

Example:

```
base_subsetq([1,2],[1,2,3,4,5]);
```

5.0.22 base_subsets_of_size

`base_subsets_of_size(K,S)`
 : It outputs all subsets of S of the size K . BUG; it uses a slow algorithm. Do not input a large S .

Example:

```
base_subsets_of_size(2,[3,5,3,2]);
```

5.0.23 base_sum

`base_sum(Obj,K,B,T)`
 : `base_sum` returns the sum of `Obj` where K runs in $[B,T]$. Options are `qt=1` (keep quote data), `step` (step size). When B is a list, K runs in B and T is ignored. When K is 0, then `Obj` is assumed to be a list or vector and `Obj[B]+...+Obj[T]` is returned.

Example 0:

```
base_sum(k^2,k,1,10);
```

Example 1:

```
base_sum(quote(x^2),x,1,10 | qt=1, step=0.5);
```

Example 2:

```
base_sum(quote(x^2),x,[a,b,c],0 | qt=1);
```

5.0.24 base_var_list

`base_var_list(Name,B,T)`

: `base_var_list` generate a list of variables Name+Index where Index runs on [B,T].

Example 0:

```
base_var_list(x,0,10);
```

Example 1:

```
base_var_list(x,1,4 | d = 1);
```

Options are d=1 (add d before the name).

6 Numbers (Standard Mathematical Functions)

6.0.1 number_abs

`number_abs(X)`

:

Example:

```
number_abs(-3);
```

6.0.2 number_ceiling

`number_ceiling(X)`

:

Example:

```
number_abs(1.5);
```

6.0.3 number_eval

`number_eval(X)`

:

Example:

```
number_eval([1/10^10,@pi,exp(1)]);
```

6.0.4 number_factor

`number_factor(X)`

: It factors the given integer X .

Example:

```
number_factor(20);
```

6.0.5 number_float_to_rational

`number_float_to_rational(X)`

:

Example:

```
number_float_to_rational(1.5234);  
number_float_to_rational(1.5234 | prec=14);
```

6.0.6 number_floor

`number_floor(X)`

:

Example:

```
number_floor(1.5);
```

6.0.7 `number_imaginary_part``number_imaginary_part(X)`

:

Example:

`number_imaginary_part(1+2*i);`**6.0.8** `number_is_integer``number_is_integer(X)`

:

Example:

`number_is_integer(2/3);`**6.0.9** `number_real_part``number_real_part(X)`

:

Example:

`number_real_part(1+2*i);`

7 Calculus (Standard Mathematical Functions)

8 Series (Standard Mathematical Functions)

9 Special Functions (Standard Mathematical Functions)

Not yet written

10 Matrix (Standard Mathematical Functions)

10.0.1 matrix_adjugate

`matrix_adjugate(M)`
: It generates the adjugate matrix of the matrix *M*.

Example:

```
matrix_adjugate(matrix_list_to_matrix([[a,b],[c,d]]));
```

10.0.2 matrix_clone

`matrix_clone(M)`
: It generates the clone of the matrix *M*.

Example:

```
matrix_clone(matrix_list_to_matrix([[1,1],[0,1]]));
```

10.0.3 matrix_det

`matrix_det(M)`
: It returns the determinant of the matrix *M*.

Example:

```
poly_factor(matrix_det([[1,x,x^2],[1,y,y^2],[1,z,z^2]]));
```

10.0.4 matrix_diagonal_matrix

`matrix_diagonal_matrix(L)`
: It returns the diagonal matrix with diagonal entries *L*.

Example:

```
matrix_diagonal_matrix([1,2,3]);
```

References:

```
matrix_list_to_matrix
```

10.0.5 matrix_eigenvalues

`matrix_eigenvalues(M)`
: It returns the eigenvalues of the matrix *M*. if the option num=1, it returns the numerical approximate eigenvalues.

Example:

```
matrix_eigenvalues([[x,1],[0,y]]);
```

10.0.6 matrix_gauge_transformation

`matrix_gauge_transformation(M, T, V)`
: It returns $T^{-1} M T - T^{-1} dT/dV$

Example:

```
matrix_gauge_transformation([[0,x],[1,x]],[[x,0],[0,1]],x);
```

10.0.7 `matrix_identity_matrix`

`matrix_identity_matrix(N)`

: It returns the identity matrix of the size N .

Example:

```
matrix_identity_matrix(5);
```

References:

`matrix_diagonal_matrix`

10.0.8 `matrix_ij`

`matrix_ij(N, II, JJ)`

: It returns the matrix for exchanging II-th row(col) and JJ-th row(col).

Example:

```
matrix_ij(4,0,2);
```

10.0.9 `matrix_image`

`matrix_image(M)`

: It computes the image of M . Redundant vectors are removed.

Example:

```
matrix_image([[1,2,3],[2,4,6],[1,0,0]]);
```

References:

`matrix_kernel`

10.0.10 `matrix_inner_product`

`matrix_inner_product(A,B)`

: It returns the inner product of two vectors A and B .

Example:

```
matrix_inner_product([1,2],[x,y]);
```

10.0.11 `matrix_inverse`

`matrix_inverse(M)`

: It returns the inverse of the matrix M .

Example:

```
matrix_inverse([[1,2],[0,1]]);
```

10.0.12 `matrix_inverse_singular`

`matrix_inverse_singular(Mat)`

: It returns a quasi-inverse matrix of Mat when it has 0-row and 0-column.

Example:

```
matrix_inverse_singular(newmat(3,3,[[1,0,2],[0,0,0],[3,0,4]]));
```

10.0.13 matrix_kernel

`matrix_kernel(M)`
 : It returns the basis of the kernel of the matrix *M*.

Example:

```
matrix_kernel([[1,1,1,1],[0,1,3,4]]);
```

10.0.14 matrix_kronecker_product

`matrix_kronecker_product(A,B)`
 : Kronecker product of the matrices *A* and *B*.

Example:

```
matrix_kronecker_product([[a11,a12],[a21,a22]],[[b11,b12],[b21,b22]]);
```

10.0.15 matrix_list_to_matrix

`matrix_list_to_matrix(M)`
 : It translates the list *M* to a matrix.

Example:

```
print_xdvi_form(matrix_list_to_matrix([[1,1],[0,2]]));
```

References:

```
matrix_matrix_to_list
```

10.0.16 matrix_matrix_to_list

`matrix_matrix_to_list(M)`
 : It translates the matrix *M* to a list.

References:

```
matrix_list_to_matrix
```

10.0.17 matrix_poly_to_matrix

`matrix_poly_to_matrix(Poly,Rule)`
 : Replace variables in the polynomial *Poly* by matrices in the *Rule*.

Example:

```
matrix_poly_to_matrix(x^2-1,[[x,newmat(2,2,[[2,0],[0,3]])]]);
```

10.0.18 matrix_rank

`matrix_rank(M)`
 : It returns the rank of the matrix *M*.

Example:

```
matrix_rank([[1,1,1,1],[0,1,3,4]]);
```

10.0.19 `matrix_rank_ff``matrix_rank_ff(Mat,P)`

: It evaluates the rank of the matrix *Mat* by mod *P*. Entries may be rational numbers, and the inverse of the denominator *D* in F_P is properly computed when *P* does not divide *D*, but the case *P* divides *D* does not raise an error.

10.0.20 `matrix_row_matrix``matrix_row_matrix(L)`

: It returns $1*n$ matrix $[[L,L,\dots,L]]$ when *L* is a scalar. It returns $1*\text{length}(L)$ matrix $[L]$.

`matrix_row_matrix(L | size=n=key0)`

: This function allows optional variables *size=n*

Example:

```
matrix_row_matrix(1 | size=5);
```

10.0.21 `matrix_solve_linear``matrix_solve_linear(M,X,B)`

: It solves the system of linear equations $M X = B$

Example:

```
matrix_solve_linear([[1,2],[0,1]],[x,y],[1,2]);
```

10.0.22 `matrix_stack``matrix_stack(A,B)`

: Stack the matrices *A* and *B*.

Example:

```
matrix_stack([[a11,a12],[a21,a22]],[[b11,b12],[b21,b22]]);
```

10.0.23 `matrix_submatrix``matrix_submatrix(M,Ind)`

: It returns the submatrix of *M* defined by the index set *Ind*.

Example:

```
matrix_submatrix([[0,1],[2,3],[4,5]],[1,2]);
```

10.0.24 `matrix_transpose``matrix_transpose(M)`

: It returns the transpose of the matrix *M*.

References:

```
matrix_list_to_matrix
```

11 Graphic (Standard Mathematical Functions)

Not yet written.

12 Print (Standard Mathematical Functions)

12.0.1 `print_c_form`

`print_c_form(S)`

: It transforms S to the C format or python format string.

Example 0:

```
print_c_form(x^2+1);
```

Example 1:

```
print_c_form(x^2+1 | mode=python);
```

Example 2:

```
print_c_form(sin(x^2+1)/5 | mode=c);
```

12.0.2 `print_dvi_form`

`print_dvi_form(S)`

: It outputs S to a dvi file.

Example:

```
print_dvi_form(x^2-1);
```

References:

```
print_xdvi_form , print_tex_form
```

12.0.3 `print_em`

`print_em(S)`

: It outputs S by a font to emphasize it.

Example:

```
print_em(x^2-1);
```

12.0.4 `print_format`

`print_format(S)`

: It changes the list format of S . Options are `list`, `sep`. Defaults are `list=["", ""]`, `sep=", "`.

Example 0:

```
print_format([1, [x, y^2]]);
```

Example 1:

```
print_format([1, [x, y^2]] | list=["(", ")"], sep=" ");
```

Example 2:

```
print_format(print_c_form([1, [x, y^2]]));
```

12.0.5 print_gif_form

`print_gif_form(S)`
 : It outputs *S* to a file of the gif format.

`print_gif_form(S | table=key0)`
 : This function allows optional variables *table*

Example:

```
print_gif_form(newmat(2,2, [[x^2,x],[y^2-1,x/(x-1)]]));
```

References:

`print_tex_form`

12.0.6 print_input_form

`print_input_form(S)`
 : It transforms *S* to a string which can be parsed by asir.

Example:

```
print_input_form(quote(x^3-1));
```

12.0.7 print_open_math_tfb_form

`print_open_math_tfb_form(S)`
 : It transforms *S* to a tfb format of OpenMath XML.

Description:

It is experimental. You need to load `taka_print_tfb.rr` to call it.

Example:

```
print_open_math_tfb_form(quote(f(x,1/(y+1))+2));
```

12.0.8 print_open_math_xml_form

`print_open_math_xml_form(S)`
 : It transforms *S* to a string which is compliant to OpenMath(1999).

Example:

```
print_open_math_xml_form(x^3-1);
```

References:

www.openmath.org

12.0.9 print_output

`print_output(Obj)`
 : It outputs the object *Obj* to a file. If the optional variable *file* is set, then it outputs the *Obj* to the specified file, else it outputs it to "asir_output_tmp.txt". If the optional variable *mode* is set to "w", then the file is newly created. If the optional variable is not set, the *Obj* is appended to the file.

`print_output(Obj | file=key0,mode=key1)`
 : This function allows optional variables *file*, *mode*

Example:

```
print_output("Hello"|file="test.txt");
```

References:

```
glib_tops , ( , )
```

12.0.10 print_ox_rfc100_xml_form

```
print_ox_rfc100_xml_form(S)
```

: It transforms S to a string which is compliant to OpenXM RFC 100.

Example:

```
print_ox_rfc100_xml_form(x^3-1);
```

References:

```
www.openxm.org
```

12.0.11 print_pdf_form

```
print_pdf_form(S)
```

: It transforms S to a pdf file and previews the file.

Example 0:

```
print_pdf_form(newmat(2,2,[[x^2,x],[y^2-1,x/(x-1)]]));
```

Example 1:

```
print_pdf_form(poly_factor(x^10-1));
```

References:

```
print_tex_form , print_xdvi_form
```

12.0.12 print_png_form

```
print_png_form(S)
```

: It transforms S to a file of the format png. dvi2png should be installed.

Example:

```
print_png_form(x^3-1);
```

References:

```
print_tex_form
```

12.0.13 print_terminal_form

```
print_terminal_form(S)
```

: It transforms S to the terminal form???

12.0.14 print_tex_form

```
print_tex_form(S)
```

: It transforms S to a string of the LaTeX format.

```
print_tex_form(S | table=key0,raw=key1)
```

: This function allows optional variables $table$, raw

Description:

The global variable `Print_tex_form_fraction_format` takes the values "auto", "frac", or "/". The global variable `Print_tex_form_no_automatic_subscript` takes the values 0 or 1. BUG; A large input S cannot be translated.

Example:

```
print_tex_form(x*dx+1 | table=[["dx","\partial_x"]]);
```

The optional variable `table` is used to give a translation table of asir symbols and tex symbols. when `AMSTeX = 1`, "begin pmatrix" and "end pmatrix" will be used to output matrix.

References:

`print_xdvi_form`

12.0.15 print_tfb_form

`print_tfb_form(S)`

: It transforms S to the tfb format.

Example:

```
print_tfb_form(x+1);
```

12.0.16 print_xdvi_form

`print_xdvi_form(S)`

: It transforms S to a xdvi file and previews the file by xdvi.

Example 0:

```
print_xdvi_form(newmat(2,2,[[x^2,x],[y^2-1,x/(x-1)]]));
```

Example 1:

```
print_xdvi_form(print_tex_form(1/2) | texstr=1);
```

References:

`print_tex_form` , `print_dvi_form`

12.0.17 print_xv_form

`print_xv_form(S)`

: It transforms S to a gif file and previews the file by xv.

`print_xv_form(S | input=key0,format=key1)`

: This function allows optional variables *input*, *format*

Example 0:

```
print_xv_form(newmat(2,2,[[x^2,x],[y^2-1,x/(x-1)]]));
```

Example 1:

```
print_xv_form(x+y | format="png");
```

If the optional variable `format="png"` is set, png format will be used to generate an input for xv.

References:

`print_tex_form` , `print_gif_form`

13 Polynomials (Standard Mathematical Functions)

13.0.1 poly_coefficient

`poly_coefficient(F, Deg, V)`

: It returns the coefficient of V^{Deg} in F . F may be rational or list or vector.

Example:

```
F=[(x+y+z)^10/z^2, (x-y+z)^10/z^3]$
poly_coefficient(F,10,x);
```

13.0.2 poly_dact

`poly_dact(Op, F, XL)`

: Act the differential operator Op to F . XL is a list of x variables.

Example:

```
poly_dact( x*dx+y*dy+a, x^(-3)*y^(-2), [x,y]);
```

13.0.3 poly_degree

`poly_degree(F)`

: It returns the degree of F with respect to the given weight vector.

`poly_degree(F | weight=key0, v=key1)`

: This function allows optional variables $weight$, v

Description:

The weight is given by the optional variable w . It returns $\text{ord}_w(F)$

Example:

```
poly_degree(x^2+y^2-4 |weight=[100,1], v=[x,y]);
```

13.0.4 poly_denominator

`poly_denominator(L)`

: It returns the denominator of L . L may be a list.

Example:

```
poly_denominator([1/(x^2-1), 1/(x^3-1)]);
```

13.0.5 poly_diff2euler

`poly_diff2euler(Op, XL)`

: Express the differential operator Op by the euler operators. XL is a list of x variables. When $XL=[x,y]$, dx, dy are differential operators and tx, ty are Euler operators ($tx=x*dx$, $ty=y*dy$). t stands for theta. When the return value is R , $R[0]*R[1]=Op$.

Example:

```
poly_diff2euler(dx^2-a*x, [x]);
```

13.0.6 poly_dmult

`poly_dmult(Op1,Op2,XL)`
 : Multiply Op1 and Op2 in the Weyl algebra (the ring of differential operators).
 XL is a list of x variables.

Example:

```
poly_dmult( x*dx+y*dy+a*x, x*y*dx*dy, [x,y]);
```

13.0.7 poly_dvar

`poly_dvar(V)`
 : Add d to the variable name V.

Example:

```
poly_dvar([x1,x2,x3]);
poly_dvar([x1,x2,x3] | d=t);
```

13.0.8 poly_elimination_ideal

`poly_elimination_ideal(I,VV)`
 : It computes the intersection of the ideal I and the subring K[VV].

`poly_elimination_ideal(I,VV | grobner_basis=key0,gb=key1,v=key2,homo=key3,grace=key4,strategy=key5)`
 : This function allows optional variables *grobner_basis*, *gb*, *v*, *homo*, *grace*, *strategy*

Description:

If *grobner_basis* is "yes" or *gb*=1, I is assumed to be a Grobner basis. The optional variable *v* is a list of variables which defines the ring of polynomials.

Example 0:

```
poly_elimination_ideal([x^2+y^2-4,x*y-1],[x]);
```

Example 1:

```
A = poly_grobner_basis([x^2+y^2-4,x*y-1] | order=2,v=[y,x]);
poly_elimination_ideal(A,[x] | grobner_basis="yes");
```

When *strategy*=1(default),
nd_gr is used when *trace*=0(default),
nd_gr_trace is used when *trace*=1.

References:

gr , *hgr* , *gr_mod* , *dp_**

13.0.9 poly_euler2diff

`poly_euler2diff(Op,XL)`
 : Translate the differential operator Op expressed in terms of euler operators into the operators in terms of d. XL is a list of x variables. When XL=[x,y], dx,dy are differential operators and tx,ty are Euler operators (tx=x*dx, ty=y*dy). t stands for theta.

Example:

```
poly_euler2diff(tx^2-x*(tx+1/2)^2,[x]);
```

13.0.10 poly_expand

`poly_expand(F)`
: This is an alias of `poly_sort`.

References:
`poly_sort`

13.0.11 poly_factor

`poly_factor(F)`
: It factorizes the polynomial F .

Example:
`poly_factor(x^10-y^10);`

13.0.12 poly_gcd

`poly_gcd(F,G)`
: It computes the polynomial GCD of F and G .

Example:
`poly_gcd(x^10-y^10,x^25-y^25);`

13.0.13 poly_gr_w

`poly_gr_w(F,V,W)`
: It returns the Grobner basis of F for the weight vector W . It is the second interface for `poly_grobner_basis`.

Example:
`poly_gr_w([x^2+y^2-1,x*y-1],[x,y],[1,0]);`

References:
`poly_in_w`, `poly_grobner_bais`

13.0.14 poly_grobner_basis

`poly_grobner_basis(I)`
: It returns the Grobner basis of I .

`poly_grobner_basis(I | order=key0,v=key1)`
: This function allows optional variables $order$, v

Description:

The optional variable v is a list of variables which defines the ring of polynomials.

Example:

```
A = poly_grobner_basis([x^2+y^2-4,x*y-1] | order=2,v=[y,x],str=1);
A->Generators;
A->Ring->Variables;
A->Ring->Order;
B = poly_grobner_basis([x^2+y^2-4,x*y-1] | order=[[10,1]],v=[y,x]);
C = poly_grobner_basis([x^2+y^2-4,x*y-1] | order=[block,[0,1],[0,1]],v=[y,x]);
```

13.0.15 poly_hilbert_polynomial

`poly_hilbert_polynomial(I)`

: It returns the Hilbert polynomial of the `poly_init(I)`.

`poly_hilbert_polynomial(I | s=key0, v=key1, sm1=key2)`

: This function allows optional variables `s`, `v`, `sm1`

Description:

The optional variable `v` is a list of variables. `sm1=1` forces to call `sm1`.
`[sum(H(k),k,0,h), H(h)]` where `H(h)` is the number of degree `h` monomials when `h>>0`. On `asir2018`, it returns `[sum(H(k),k,0,h), H(h),[H[0],H[1],...],F,d]` where `F/(1-h)^d` is the Poincare series.

Example:

```
poly_hilbert_polynomial([x1*y1,x1*y2,x2*y1,x2*y2] | s=k, v=[x1,x2,y1,y2]);
```

13.0.16 poly_ideal_colon

`poly_ideal_colon(I, J, V)`

: It computes the colon ideal of `I` by `J` `V` is the list of variables.

Example:

```
B=[(x+y+z)^50, (x-y+z)^50]$
V=[x, y, z]$
B=poly_ideal_colon(B, [(x+y+z)^49, (x-y+z)^49], V);
```

13.0.17 poly_ideal_intersection

`poly_ideal_intersection(I, J, V, Ord)`

: It computes the intersection of the ideal `I` and `J` `V` is the list of variables.
`Ord` is the order.

Example:

```
A=[j*h*g*f*e*d*b, j*i*g*d*c*b, j*i*h*g*d*b, j*i*h*e*b, i*e*c*b, z]$
B=[a*d-j*c, b*c, d*e-f*g*h]$
V=[a, b, c, d, e, f, g, h, i, j, z]$
poly_ideal_intersection(A, B, V, 0);
```

13.0.18 poly_ideal_saturation

`poly_ideal_saturation(I, J, V)`

: It computes the saturation ideal of `I` by `J`. `V` is the list of variables.

Example:

```
B=[(x+y+z)^50, (x-y+z)^50]$
V=[x, y, z]$
B=poly_ideal_saturation(B, [(x+y+z)^49, (x-y+z)^49], V);
```

13.0.19 poly_in`poly_in(I)`: It is an alias of `poly_initial()`.`poly_in(I | order=key0, v=key1)`: This function allows optional variables `order`, `v`

Example:

```
poly_in([x^2+y^2-4, x*y-1] | order=0, v=[x, y]);
poly_in([x^2+y^2-4, x*y-1] | order=[1, 0], v=[x, y]);
```

13.0.20 poly_in_w`poly_in_w(F, V, W)`: It returns the initial term or the initial ideal `in_w(F)` for the weight vector given by `order`. `F` is a single polynomial or a list of polynomials.`poly_in_w(F, V, W | gb=key0)`: This function allows optional variables `gb`

Example:

```
poly_in_w([x^2+y^2-1, x*y-x], [x, y], [1, 0]);
```

References:

```
poly_weight_to_omatrix, (, W, V, ), poly_grobner_basis, poly_gr_w,
poly_in_w_
```

13.0.21 poly_in_w_`poly_in_w_(F)`: It returns the initial term or the initial ideal `in_w(F)` for the weight vector given by `order`. `F` is a single polynomial or a list of polynomials. This is a new interface of `poly_in_w` with shorter args.`poly_in_w_(F | v=key0, weight=key1, gb=key2)`: This function allows optional variables `v`, `weight`, `gb`

Example:

```
poly_in_w_([x^2+y^2-1, x*y-x] | v=[x, y], weight=[1, 0]);
```

References:

```
poly_weight_to_omatrix, (, W, V, ), poly_grobner_basis, poly_gr_w
```

13.0.22 poly_initial`poly_initial(I)`: It returns the initial ideal of `I` with respect to the given order.`poly_initial(I | order=key0, v=key1)`: This function allows optional variables `order`, `v`

Description:

The optional variable `v` is a list of variables. This function computes `in_<(I)`

Example:

```
poly_initial([x^2+y^2-4,x*y-1] | order=0,v=[x,y]);
poly_initial([x^2+y^2-4,x*y-1] | order=0,v=[x,y],gb=1);
poly_in([x^2+y^2-4,x*y-1] | order=[1,0],v=[x,y]);
```

13.0.23 poly_initial_coefficients

`poly_initial_coefficients(I)`

: It computes the coefficients of the initial ideal of I with respect to the given order.

`poly_initial_coefficients(I | order=key0,v=key1)`

: This function allows optional variables *order*, *v*

Description:

The optional variable *v* is a list of variables. The order is specified by the optional variable *order*

Example:

```
poly_initial_coefficients([x^2+y^2-4,x*y-1] | order=0,v=[x,y]);
```

13.0.24 poly_initial_term

`poly_initial_term(F)`

: It returns the initial term of a polynomial F with respect to the given weight vector.

`poly_initial_term(F | weight=key0,order=key1,v=key2)`

: This function allows optional variables *weight*, *order*, *v*

Description:

The weight is given by the optional variable *weight* w . It returns $\text{in}_w(F)$

Example:

```
poly_initial_term(x^2+y^2-4 | weight=[100,1],v=[x,y]);
```

13.0.25 poly_lcm

`poly_lcm(L)`

: It returns the LCM of $L[0]$, $L[1]$, ...

Example:

```
poly_lcm([x^2-1,x^3-1]);
```

13.0.26 poly_ord_w

`poly_ord_w(F,V,W)`

: It returns the order with respect to W of F .

Example:

```
poly_ord_w(x^2+y^2-1,[x,y],[1,3]);
```

References:

`poly_in_w`

13.0.27 poly_prime_dec

`poly_prime_dec(I, V)`

: It computes the prime ideal decomposition of the radical of I . V is a list of variables.

Example:

```
B=[x00*x11-x01*x10,x01*x12-x02*x11,x02*x13-x03*x12,x03*x14-x04*x13,
  -x11*x20+x21*x10,-x21*x12+x22*x11,-x22*x13+x23*x12,-x23*x14+x24*x13];
V=[x00,x01,x02,x03,x04,x10,x11,x12,x13,x14,x20,x21,x22,x23,x24];
poly_prime_dec(B,V | radical=1);
```

13.0.28 poly_r_omatrix

`poly_r_omatrix(N)`

: It gives a weight matrix, which is used to compute a Grobner basis in $K(x)\langle dx \rangle$, $|x|=|dx|=N$.

Example:

```
poly_r_omatrix(3);
```

References:

```
poly_weight_to_omatrix , ( , W , V , ) , ;
```

13.0.29 poly_solve_linear

`poly_solve_linear(Eqs, V)`

: It solves the system of linear equations Eqs with respect to the set of variables V . When the option $p=P$ is given, it solves the system by mod P . When the option $reverse=1$ is given, the lex order of $reverse(V)$ is used.

Example:

```
poly_solve_linear([2*x+3*y-z-2, x+y+z-1], [x,y,z]);
poly_solve_linear([2*x+3*y-z-2, x+y+z-1], [x,y,z] | p=13);
```

13.0.30 poly_sort

`poly_sort(F)`

: It expands F with a given variables $v=V$ and a given weight $w=W$. It returns a quote object. If *truncate* option is set, the expansion is truncated at the given degree.

`poly_sort(F | v=key0,w=key1,truncate=key2)`

: This function allows optional variables v , w , *truncate*

Example:

```
poly_sort((x-y-a)^3 | v=[x,y], w=[-1,-1])
returns a series expansion in terms of x and y.
```


13.0.31 poly_toric_ideal`poly_toric_ideal(A,V)`

: It returns generators of the affine toric ideal defined by the matrix(list) A. V is the list of variables.

Example:

```
poly_toric_ideal([[1,1,1,1],[0,1,2,3]],base_var_list(x,0,3));
```

13.0.32 poly_weight_to_omatrix`poly_weight_to_omatrix(W,V)`

: It translates the weight vector W into a matrix, which is used to set the order in asir Grobner basis functions. V is the list of variables.

Example:

```
M=poly_weight_to_omatrix([2,1,0],[x,y,z]);  
nd_gr([x^3+z^3-1,x*y*z-1,y^2+z^2-1,[x,y,z],0,M);
```

14 Complex (Standard Mathematical Functions)

15 Graphic Library (2 dimensional)

The library `glib` provides a simple interface like old BASIC to the graphic primitive (`draw_obj`) of Risa/Asir.

15.0.1 `glib_clear`

`glib_clear()`
: Clear the screen.

15.0.2 `glib_flush`

`glib_flush()`
: ; Flush the output. (Cfep only. It also set `initGL` to 1.).

15.0.3 `glib_line`

`glib_line(X0,Y0,X1,Y1)`
: It draws the line $[X0,Y0]$ – $[X1,Y1]$ with *color* and *shape*

`glib_line(X0,Y0,X1,Y1 | color=key0,shape=key1)`
: This function allows optional variables *color*, *shape*

Example:

```
glib_line(0,0,5,3/2 | color=0xff00ff);
glib_line(0,0,10,0 | shape=arrow);
```

15.0.4 `glib_open`

`glib_open()`
: It starts the `ox_plot` server and opens a canvas. The canvas size is set to `Glib_canvas_x` X `Glib_canvas_y` (the default value is 400). This function is automatically called when the user calls `glib` functions.

15.0.5 `glib_plot`

`glib_plot(F)`
: It plots an object *F* on the `glib` canvas.

Example 0:

```
glib_plot([[0,1],[0.1,0.9],[0.2,0.7],[0.3,0.5],[0.4,0.8]]);
```

Example 1:

```
glib_plot(tan(x));
```

15.0.6 `glib_print`

`glib_print(X,Y,Text)`
: It put a string *Text* at $[X,Y]$ on the `glib` canvas.

`glib_print(X,Y,Text | color=key0)`
: This function allows optional variables *color*

Example:

```
glib_print(100,100,"Hello Worlds" | color=0xff0000);
```

15.0.7 glib_ps_form

`glib_ps_form(S)`

: It returns the PS code generated by executing *S* (experimental).

Example 0:

```
glib_ps_form(quote( glib_line(0,0,100,100) ));
```

Example 1:

```
glib_ps_form(quote([glib_line(0,0,100,100),glib_line(100,0,0,100)]));
```

References:

`glib_tops`

15.0.8 glib_putpixel

`glib_putpixel(X,Y)`

: It puts a pixel at $[X,Y]$ with *color*

`glib_putpixel(X,Y | color=key0)`

: This function allows optional variables *color*

Example:

```
glib_putpixel(1,2 | color=0xffff00);
```

15.0.9 glib_remove_last

`glib_remove_last()`

: Remove the last object. `glib_flush()` should also be called to remove the last object. (cfep only).

15.0.10 glib_set_pixel_size

`glib_set_pixel_size(P)`

: Set the size of putpixel to *P*. 1.0 is the default. (cfep only).

15.0.11 glib_tops

`glib_tops()`

: If `Glib_ps` is set to 1, it returns a postscript program to draw the picture on the canvas.

References:

`print_output`

15.0.12 glib_window

`glib_window(Xmin,Ymin,Xmax,Ymax)`

: It generates a window with the left top corner $[Xmin,Ymin]$ and the right bottom corner $[Xmax,Ymax]$. If the global variable `Glib_math_coordinate` is set to 1, mathematical coordinate system will be employed, i.e., the left top corner will have the coordinate $[Xmin,Ymax]$.

Example:

```
glib_window(-1,-1,10,10);
```

16 OpenXM-Contrib General Functions

16.1 Functions

16.1.1 ox_check_errors2

`ox_check_errors2(p)`

:: get a list of error objects on the stack of the server *p*.

return List

p Number

- It gets a list of error objects on the server stack.
- It does not pop the error objects.

```
[219] P=sm1.start();
```

```
0
```

```
[220] sm1.sm1(P," 0 get ");
```

```
0
```

```
[221] ox_check_errors2(P);
```

```
[error([7,4294967295,executeString: Usage:get])]
```

```
Error on the server of the process number = 1
```

```
To clean the stack of the ox server,
```

```
type in ox_pops(P,N) (P: process number, N: the number of data you need to pop)
out of the debug mode.
```

```
If you like to automatically clean data on the server stack,
```

```
set XM_debug=0;
```

17 OXshell Functions

OXshell is a system to execute system commands from ox servers. As to details, see the files OpenXM/src/kan96xx/Doc/oxshell.oxw and OpenXM/doc/Papers/rims-2003-12-16-ja.tex.

17.0.1 oxshell.get_value

`oxshell.get_value(NAME, V)`

: It get the value of the variable *NAME* on the server *ox_shell*.

Example:

```
oxshell.set_value("abc", "Hello world!");
oxshell.oxshell(["cp", "stringIn://abc", "stringOut://result"]);
oxshell.get_value("result");
```

What we do is a file `$TMP/abc*` is generated with the contents Hello world! and copied to `ox_sm1`. The contents of the file is stored in the variable `result` on `ox_sm1`.

References:

`oxshell.oxshell` , `oxshell.set_value`

17.0.2 oxshell.oxshell

`oxshell.oxshell(L)`

: It executes command *L* on a *ox_shell* server. *L* must be an array. The result is the outputs to stdout and stderr. A temporary file will be generated under `$TMP`. cf. `oxshell.keep_tmp()`

Example:

```
oxshell.oxshell(["ls"]);
```

References:

`ox_shell` , `oxshell.set_value` , `oxshell.get_value` , `oxshell` , `of` , `sm1`.

17.0.3 oxshell.set_value

`oxshell.set_value(NAME, V)`

: It set the value *V* to the variable *Name* on the server *ox_shell*.

Example:

```
oxshell.set_value("abc", "Hello world!");
oxshell.oxshell(["cat", "stringIn://abc"]);
```

References:

`oxshell.oxshell` , `oxshell.get_value`

18 Asir System Utility Functions

18.0.1 asir_contrib_update

`asir_contrib_update()`

: It updates the asir-contrib library and/or some other files to the HEAD branch. The usage will be shown by `asir_contrib_update()` without the option `update`. Options are `update`, `clean`, `url`, `install_dir`, `zip_files`, `tmp`. Default values `update=0`, `clean=0`, `url="http://www.math.kobe-u.ac.jp/OpenXM/Current"`, `install_dir=%APPDATA%/OpenXM (win)` or `install_dir=$OpenXM_tmp/OpenXM (others)` `zip_files=["lib-asir-contrib.zip"]`

Example:

```
asir_contrib_update();  
asir_contrib_update(|update=1);    update the library  
asir_contrib_update(|update=3);    update the library and the documents  
asir_contrib_update(|clean=1);  
asir_contrib_update(|zip_files=["lib-asir-contrib.zip","doc-asir2000.zip","doc-asir
```

19 Utility Functions

Utility functions provide some useful functions to access to the system and to process strings.

19.0.1 util_damepathq

`util_damepathq(S)`

: When *S* is a string by the ShiftJIS code and *S* contains dame-moji with respect to \, it returns [a non-zero number, the string].

Example:

```
T = [0x5c,0xe4,0x5c,0x41,0x42]$
T2=asciitostr(T)$
util_damepathq(T2);
```

19.0.2 util_file_exists

`util_file_exists(Fname)`

: It returns 1 when *Fname* exists. It returns 0 when *Fname* does not exist.

19.0.3 util_filter

`util_filter(Command,Input)`

: It executes the filter program *Command* with the *Input* and returns the output of the filter as a string.

`util_filter(Command,Input | env=key0)`

: This function allows optional variables *env*

Example:

```
util_filter("sort","cat\ndog\ncentipede\n");
```

19.0.4 util_find_and_replace

`util_find_and_replace(W,S,Wnew)`

: It replaces *W* in *S* by *Wnew*. Arguments must be lists of ascii codes or strings.

19.0.5 util_find_start

`util_find_start()`

: It tries to find the gnome-open command or an installed browser in unix systems. It returns "open" on MacOS X and returns "start" on Windows.

`util_find_start(| browser=key0)`

: This function allows optional variables *browser*

19.0.6 util_find_substr

`util_find_substr(W,S)`

: It returns the position of *W* in *S*. If *W* cannot be found, it returns -1. Arguments must be lists of ascii codes or strings.

19.0.7 util_index

`util_index(V)`

: It returns the name part and the index part of V .

Example:

```
util_index(x_2_3)
```

References:

`util_v`

19.0.8 util_load_file_as_a_string

`util_load_file_as_a_string(F)`

: It reads a file F as a string.

19.0.9 util_part

`util_part(S,P,Q)`

: It returns from P th element to Q th element of S .

19.0.10 util_read_file_as_a_string

`util_read_file_as_a_string(F)`

: It reads a file F as a string.

19.0.11 util_remove_cr

`util_remove_cr(S)`

: It removes `cr/lf/tabs` from S . Arguments must be a list of ascii codes.

19.0.12 util_timing

`util_timing(Q)`

: Show the timing data to execute Q .

Example:

```
util_timing( quote( fctr(x^50-y^50) ));
```

19.0.13 util_v

`util_v(V,L)`

: It returns a variable indexed by L .

Example:

```
util_v("x",[1,3]);
```

References:

`util_index`

19.0.14 util_write_string_to_a_file

`util_write_string_to_a_file(Fname,S)`

: It writes a string S to a file $Fname$.

20 Other Manuals

This section introduces other manuals in the asir-contrib project.

This section also describes functions that have not yet been classified. These will be moved to independent sections in a future.

20.0.1 dsolv (Solving the initial ideal for holonomic systems)

`../dsolv-html/dsolv-en.html`

20.0.2 gtt_ekn (Two way contingency tables by HGM)

`../gtt_ekn-html/gtt_ekn-en.html`

20.0.3 f_res (Comuting resultant)

`../f_res-html/f_res-en.html`

20.0.4 (gnuplot ox server for graphics)

`../gnuplot-html/gnuplot-en.html`

20.0.5 mathematica (Mathematica (TM) ox server)

`../mathematica-html/mathematica-en.html`

20.0.6 mt_graph (3D grapher)

`../mk_graph-html/mk_graph-en.html`

20.0.7 mt_gkz (Intersection matrix of GKZ systems)

`../mt_gkz-html/mt_gkz-en.html`

20.0.8 n_wishartd (restriction of matrix 1F1)

`../n_wishartd-html/n_wishartd-en.html`

20.0.9 nn_ndbf (local b-function)

`../nn_ndbf-html/nn_ndbf-en.html`

20.0.10 noro_mwl (Mordel Weil Lattice)

`../noro_mwl-html/noro_mwl-en.html`

20.0.11 noro_module_syz (syzygies for modules)

`../noro_module_syz-html/noro_module_syz-en.html`

20.0.12 ns_twistedlog (twisted logarithmic cohomology group)

`../ns_twistedlog-html/ns_twistedlog-en.html`

20.0.13 nk_fb_gen_c (Fisher Bingham MLE)

`../nk_fb_gen_c-html/nk_fb_gen_c-en.html`

20.0.14 ok_diff (Okutani's library for differential operators)`../ok_diff-html/ok_diff-en.html`**20.0.15 ok_dmodule (Okutani's library for D-modules)**`../ok_dmodule-html/ok_dmodule-en.html`**20.0.16 om (om (java) ox server for translating CMO and OpenMath)**`../om-html/om-en.html`**20.0.17 ox_pari (OpenXM pari server)**`../ox_pari-html/ox_pari-en.html`**20.0.18 (Plucker relations)**`../plucker-html/plucker-en.html`**20.0.19 pfpcoh (Ohara's library for homology/cohomology groups for $p \mathbb{F}_q$)**`../pfpcoh-html/pfpcoh-en.html`**20.0.20 phc (PHC ox server for solving systems of algebraic equations by the homotopy method)**`../phc-html/phc-en.html`**20.0.21 sm1 (Kan/sm1 ox server for the ring of differential operators)**`../sm1-html/sm1-en.html`**20.0.22 tigers (tigers ox server for toric universal Grobner bases)**`../tigers-html/tigers-en.html`**20.0.23 tk_ode_by_mpfr (Generating C codes for numerical analysis of ODE by MPFR, document in Japanese)**`../tk_ode_by_mpfr-html/tk_ode_by_mpfr-ja.html`**20.0.24 [[todo_parametrize]]**`todo_parametrize/todo_parametrize.toc`

With loading the file `todo_parametrize/todo_parametrize.rr` the function `parametrize` is installed. The function finds a parametric expression of a given rational curve. As to details, see *See A package for algebraic curves* (in Japanese).

```
[1205] load("todo_parametrize/todo_parametrize.rr");
1
[1425] parametrize(y^2-x^3);
```

```
[155*t^2+20*t+1,720*t^4+1044*t^3+580*t^2,155*t^4+20*t^3+t^2,(-x)/(y)]  
[1426] parametrize(y^2+x^3);  
[-t,1,t^3,(-x)/(y)]
```

20.0.25 taji_alc

With loading the file `taji_alc.rr` functions for algebraic local cohomology groups in one variable are imported.

```
import("taji_alc.rr");  
taji_alc.laurent_expansion(x,(x-1)^3);
```

20.0.26 Manual and papers which are not written in texinfo.

Links to manuals and papers related to files and commands in `asir-contrib` are at OpenXM documents (<http://www.math.kobe-u.ac.jp/OpenXM/Current/doc/index-doc-en.html>).

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